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COMPLETE SPECIFICATION

Method of and Apparatus for Twisting Yarn

We, HOWE TWISTER CORPORATION, a corporation organized and existing under the laws of the State of New Jersey, United States of America, of 15, Exchange Place, Jersey City, State of New Jersey, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to a method of and an apparatus for twisting yarn. More particularly the invention relates to the twisting of yarn or threads and the cabling of such threads into a cabled cord.

The invention has among its objects, the provision of an improved method for twisting the yarn and the cabling of the threads to cords.

Another object of the invention lies in the provision of a relatively simple apparatus, which is flexible in its operation, for carrying out such method.

These and further objects of the invention will be more readily apparent in the following description of preferred embodiments of the method and apparatus of the invention.

There is a wide-spread need in industry for cabling of threads. Among the most common uses for such cabled threads may be cited their employment as reinforcing cords in automobile tires and in V belts. It is most usual at present to employ for such causes the various artificial or synthetic fibres, such as rayon and nylon, because of their strength, and their heat and flexure resistance. Such materials are formed as fine fibers extruded from spinnerets, a plurality of such fibers being wound in the form of a "cake." It is with the forming of cords from such yarns with which the present invention is primarily concerned, although it is to be understood that the method and the apparatus of the invention may be used to advantage in forming cords from other fine fiber threads and also from fine wire. The words "yarn," "thread," and "cord" as used in the present specification and claims are therefore to be broadly construed to include such materials, although the invention will be particularly described in connection with the twisting of rayon yarn to form cords.

In practising prior art methods for performing such yarn twisting operation, it has been necessary, first, to form a plurality of separate threads by twisting the yarns usually all in one direction, the resulting threads being wound upon a separate bobbin for each thread. Such threads were then, in a separate, subsequent, operation, fed from such bobbins and twisted together, usually in a direction opposite to the direction of twist of the individual threads. There were thus necessary two separate and distinct operations, each of which involved feeding from bobbins, twisting (more properly cabling in the second operation), and winding the resultant twisted product on a bobbin. Such prior method was unduly time consuming, and in effect required a duplication of at least some of the elements of the apparatus, in carrying out the two twisting steps of the method.

The invention comprises the method of producing twisted filamentary material, characterised in that it comprises continuously twisting a strand of filamentary material such as yarn extending from a source of supply thereof in a loop while rotating such loop about the supply source to form a first balloon, forwarding twisted material from said balloon into another loop and thence into a take-up portion of the path of the material, continuously twisting the forwarded material by rotating the loop thereof about said take-up portion to form a second balloon which exerts centrifugally a pull on the twisted material opposing the centrifugally

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exerted pull thereon of said first balloon, and continuously taking up the material within the orbit of said second balloon to maintain continuous longitudinal travel of material from the supply source through the balloons while plurally twisting the material.

Further, the invention comprises apparatus for producing twisted filamentary material according to the method of the preceding paragraph, characterised by including a two-for-one twisting spindle of the type which holds a supply of the filamentary material and forms a strand of the same issuing therefrom into the first balloon, means associated with said spindle for imposing a predetermined back tension on such strand, a two-for-one twisting device of the type which receives and takes up filamentary material and forms the material received into a balloon rotating about a take-up portion of the material, such device including means for positively drawing in twisted material from the latter balloon; means for leading twisted material from the first balloon continuously into the latter balloon to form the latter; and means for driving said twisting spindle and said twisting device in synchronism.

Figure 1 is a view in perspective of a preferred embodiment of the yarn twisting machine of the invention;

Figure 2 is a view in front elevation of such machine, the view being taken from a plane parallel to that containing the axis of the yarn supplying bobbins;

Figure 3 is a somewhat diagrammatic view in vertical transverse section through the apparatus, the spindles, at the left in Figure 3, being shown as they appear from the line III—III in Figure 2, and the supporting structure therefor, at the right in Figure 3 being shown as it appears from a vertical transverse plane through the line III—III and thus through the right-hand end of the frame shown in Figure 1;

Figure 4 is a fragmentary view in plan of the apparatus shown in Figures 2 and 3;

Figure 5 is a view in vertical section through the axis of the double twisting device serving as a support for a yarn supplying bobbin;

Figure 6 is an enlarged view in vertical section showing details of construction of the device shown in Figure 5;

Figure 7 is a view in side elevation of a stationary yarn tensioning device employed in the apparatus shown in Figure 5;

Figure 8 is a view similar to that of Figure 7 with the tensioning device turned 90° about its longitudinal axis;

Figure 9 is a view in section through the longitudinal axis of the yarn tensioning device, in operative condition, the section being taken along the line IX—IX in Figure 7;

Figure 10 is a view similar to that of Figure 9 with the yarn engaging and tensioning blocks open;

Figure 11 is a view in perspective of a yarn engaging block employed in the yarn tensioning device;

Figure 12 is a view in vertical section through the axis of the cabling unit;

Figure 13 is a view in cross-section through such cabling unit, the section being taken along the line XIII—XIII in Figure 12;

Figure 14 is an enlarged view in vertical cross-section through the base of the cabling unit, the section being taken along the line XIV—XIV in Figure 13;

Figure 15 is a view in front elevation of the traverse mechanism for the loading finger employed with the cabling unit;

Figure 16 is a view in side elevation of such traverse mechanism;

Figure 17 is a view in rear elevation of the traverse mechanism;

Figure 18 is a view in plan of the traverse mechanism;

Figure 19 is a horizontal section through the traverse mechanism, the section being taken along the line XIX—XIX in Figure 15;

Figure 20 is a fragmentary view in side elevation of the loading finger supporting unit;

Figure 21 is a view in plan of the unit shown in Figure 20; and

Figure 22 is a view in vertical section through such unit, the section being taken along the line XXII—XXII in Figure 20.

The preferred embodiment of the yarn twisting apparatus of the invention, which is shown more generally in Figures 1 to 4, inclusive, includes a framework generally designated 2, of which the corner vertical supports are designated 4, the lower front cross member 6, the lower rear cross member 8, the intermediate rear cross member 14, the top front cross member 10, and the top rear cross member 12. In Figures 2 to 4, inclusive, such framework is generally omitted, only the additional lower cross member 46 forming the supporting means for the yarn twisting units and the cabling unit being shown. Member 46 is attached to intermediate end frame members, of which one is shown at 16 in Figure 1. In the apparatus illustrated, there are employed two bobbin supporting and yarn twisting units, the left hand such unit being designated 20, and the right hand such unit

being designated 22. It is to be understood that the invention is not limited to the use of two such units, each supplying a twisted thread to the cabling unit, but that there may be employed any desired number, from two upwards, of yarn twisting units, depending upon the number of twisted threads desired in the cord. It is also to be understood that whereas in the device shown the two threads are twisted separately in the same direction (hand) and are twisted together to form a cord in the direction (hand) opposite to the twist of the individual threads, such procedure is subject to variation as desired. Thus it is possible to twist the threads themselves and the threads together all in the same direction, or to twist some of the individual threads in one direction and some in the other. In the last case, the threads will usually be twisted together to form a cord in a direction opposite to that of the twist of the majority of threads being twisted together.

The cabling unit shown at 24 is preferably, although not necessarily, located between twisting units 20 and 22. In the embodiment shown, the axes of the units 20, 22, and 24 lie in a common plane. The axes of units 20 and 22 are spaced equal distances from that of unit 24, as shown in Figure 2. A capstan 33 is located with its axis substantially at a right angle to the axis of unit 24, the projected axis of unit 24 substantially intersecting the projected axis of the capstan, as is evident from Figures 1 to 4 inclusive. As a result, threads 28 and 32 travel substantially equal distances from their respective guiding eyes 114 to the capstan 33.

Generally the yarn, shown wound on a bobbin at 26 in the twisting unit 20, is fed therefrom in the form of a twisted thread 28, and the similar yarn shown at 30 in twisting unit 22 is fed therefrom as twisted thread 32. Preferably the yarn is in the form of "flat yarn," that is, one in the form of a tape of generally rectangular cross-section, the width of the tape materially exceeding its thickness. The two such twisted threads are brought together at the capstan 33 in parallel untwisted relationship, from the stepped capstan 33 they continue their travel in such relationship through a compensator and-shock absorber generally designated 35, from which they emerge, as shown at 34. In that portion of their travel downwardly from the compensator until they enter the cabling unit 24, the two threads are given one twist about each other, and in that portion of their travel shown at 36 in which they rise through the center of the cord receiving bobbin, they receive another twist, following which they are laid onto the bobbin, as shown at 37.

The yarn twisting units 20 and 22, the cabling unit 24, and the stepped capstan 33, are all driven by means of a vertically mounted electric motor 38 secured to the frame. A flat belt 42 passes over the motor pulley 40 and over an idler pulley 44. The idler pulley is supported on the member 46 by means of an intermediate support 48, units 20, 22, and 24 likewise deriving their support from the member 46. The member 46 is braced against turning by reason of the connection between a part 58, attached thereto, and a cross member of the frame. (See Figure 3). Such frame cross member has a front portion 59 at right angles to the spindles terminating at the member 58, and a horizontal rear part 61 attached to the rear of the frame. Unit 20 is supported on a sleeve, shown at 50, connected to intermediate support and journal bearing 52. Unit 24 is provided with a supporting sleeve, generally designated 56, which is supported in the member 58 which also includes bearings, and unit 22, which is similar in all respects to unit 20, has the supporting sleeve 62 journaled in the support 64. As will be apparent from Figure 2, the two yarn twisting units and the cabling unit are provided with drive pulleys engaging the same run of belt 42, pulley 67 for unit 20 and pulley 66 for unit 22 being positioned in front of such run of the belt 42 shown in Figure 2, and pulley 60 for unit 24 being positioned at the back of such run of the belt. Thus pulleys 66 and 67 and the parts of units 20 and 22 connected thereto, respectively, rotate in one direction, and pulley 60 of unit 24 and the parts connected to such pulley rotate in the opposite direction.

The capstan or gathering pulley 33, referred to above, imposes compensating tension upon the strands passing around it from the singles balloons and extending to the central or cabling balloon, by reason of the following: Capstan 33 is rotated by a positive drive connection at a speed correlated to the speed of the singles twisters and the speed of the cabling twister, and has frictional engagement with the gathered strands wrapped around it. The gathering means thus serves as a tension-producing means, or in other words as a compensating tension imposing means, in either of two ways: When the conditions of operation are such that the tension in the gathered strands entering the cabling balloon exceeds the sum of the counteracting tensions in the strands leaving the singles balloons, which is the case when the apparatus of the invention is used for twisting rayon yarns into cord,

to form a cord such as tire cord, the gathering pulley imposes a frictional resistance against travel of the strands at a speed greater than its peripheral speed and thus counteracts the excess tension of the cabling balloon. Under these conditions the gathering means retards the travel of the gathered strands, and its drive connection can serve only to control the rate of strand travel by restraining the rotation of the gathering means. If the conditions of operation are such that the sum of the tension of the strands leaving the singles balloons is greater than the tension in the gathered strands entering the cabling balloon, the gathering pulley 33 overcomes the excess tension on the singles side of the system and thus serves as a driving means to keep the strands advancing into the cabling balloon at a substantially constant speed. In the particular form of apparatus shown, the magnitude of the retarding counter tension or the forwarding pull exerted on the strands by the gathering means, according to the conditions of use of the machine, depends upon the resistance existing at the pulley 33 against free movement of the strands, i.e., in this form upon the resistance exerted by the pulley against free relative motion or slippage between the gathered strands and the pulley; and this in turn is affected by several factors including the area of contact therebetween, the shape of the pulley and the coefficient of friction between the strands and the pulley.

The structure of the yarn supplying and yarn twisting units 20 and 22 will be more readily understood by reference to Figures 5 and 6, which show in detail the structure of unit 22. The supporting sleeve 62 is attached, as shown, to the intermediate support 64. Such sleeve carries journaled with it an upright spindle of which the bottom portion is designated 68, and the upper axially bored portion integral therewith is designated 74. A ball bearing 70 is provided between the spindle and the sleeve at the bottom ends of both, and a ball bearing 72 is provided between the spindle intermediate its ends and the upper end of the sleeve. The spindle thus rotates freely in its supporting sleeve.

The axial passage through the upper portion of the spindle is shown at 76. Such passage communicates at its lower end with a segmental slot 78, the inner wall of which is curved as shown. The upper end of spindle part 74 is provided with a yarn engaging twisting guide 80 fastened thereto to rotate with the spindle. Guide 80 may be any one of a number of conventional devices for such purpose. In its preferred form, such guide takes the form of two twisting blocks having generally flat confronting faces spaced slightly apart, between which the yarn travels. Such blocks may have a configuration similar to that of block 128 (Figure 11), except that their rear faces need not be rounded. The spindle 68 is rotated by means of the pulley 66 keyed thereto, the spindle also carrying a thread twisting delivery disc 82 having the radially directed tube 84 located therein, the inner end of which, as shown more clearly in Figure 6, communicates with the segmental slot 78. Rotation of the pulley 66, as is clearly apparent from Figures 5 and 6, rotates the disc 82 and twisting guide 80.

Supported on the spindle in floating relationship therewith is the bobbin supporting structure, indicated generally at 86. Such structure includes an upstanding sleeve 88 surrounding spindle part 74, the sleeve being supported on the spindle through the medium of an upper ball bearing 90 and a lower ball bearing 92. Structure 86 also includes a radially directed disc portion 94 having a depending flange 96 thereon. Such structure 86 is provided at one zone with a weight, shown at 97 in the form of a cast lead mass, so that the floating bobbin supporting structure is unbalanced. When the structure shown in Figure 5 is mounted as shown in Figure 1, with its axis at a substantial angle to the vertical, structure 86 tends to remain with the weight 97 positioned downwardly.

The bobbin shown at 98 is fixedly positioned on the supporting structure 86, a stationary tension device 100 being positioned within the bobbin and coaxially thereof by means of a supporting member shown at 102. Unit 22 is covered by an outer can 104 attached to the outer face of flange 96 and by a conical cover 106 fitting on top of the can. When the unit shown in Figure 5 is operated by the driving pulley 66, untwisted flat yarn, shown at 108, is fed from the bobbin into the upper end of the tension device 100. The yarn engaging jaws of such device, subsequently to be more fully described, are as stated, stationary, with respect to the bobbin, and thus the yarn is given a first twist in the portion 110 between tension device 100 and rotary twisting guide 80. The single twisted thread, designated 112, is fed downwardly through passage 76 in the spindle into tube 84, from the outer end of which it is fed upwardly to the stationary eye 114, which is attached to a part of the machine frame. In that portion of its travel shown at 116, from the outer edge of disc 82 to the eye 114,

the thread receives a further twist; thus the units 20 and 22 shown are called "double twisting spindles." The floating mounting of the hobbin support cushions the yarn against accelerations such as occur when the machine is started. When the machine has come up to speed and the parts have reached equilibrium, support 86, as stated, tends to float in one position and merely to rock thereabout rather than to rotate about the spindle. Units 20 and 22, which may also be called "two-for-one" twisting units, effect an operation which is sometimes termed "two-for-one" twisting.

By reason of the rotation of disc 82 on each of the units 20 and 22, each of the threads 28 and 32 fed from such units, respectively, upwardly through an eye 114 forms a balloon which travels in free flight through the air, as indicated in Figure 2. Eyes 114 are located coaxially of the units and above them, as indicated in Figures 2 and 3, each eye 114 being located the same distance from the top end of its respective unit. Thus when the yarns forming threads 28 and 32 are substantially identical, because of the substantial identity of the units 20 and 22 and of the speeds at which they are rotated, the balloons formed in threads 28 and 32 in the portion 116 of the run of each will be substantially identical in width and the tensions in such threads 28 and 32 will be substantially the same when the tension device 100 of each of units 20 and 22 is adjusted to the same point.

The stationary tension device 100, positioned within the bobbin 98, is more clearly shown in Figures 7—10, inclusive.

In Figures 7 and 8 the device is shown in side elevation in positions turned 90° about its longitudinal axis. In Figure 9 it is shown in longitudinal section with the tension blocks together in operative relationship, and in Figure 10 it is shown with the springs which tend to thrust the tension blocks together relieved from contact with the blocks so that tension is removed from the yarn passing between such blocks.

The tension device comprises an elongated main body having a cylindrical upper end 118 and a lower end 120 generally square in cross-section. The upper end 118 has an axial bore 122 therethrough, and the lower end has an axial bore 124 through it, so that yarn may be passed longitudinally through the body. The lower end 120 is provided with a transverse passageway 126 within which the tension blocks 128 are slidably received. To facilitate removal of the tension blocks, body 120 is provided with a further transverse slot 129 at right angles to passageway 126, so that the blocks may be removed from the device through slot 129. The outer ends of slot 129 are partially covered, as shown in Figure 8, by the removable cover plates 127.

The tension blocks are generally of the shape shown in Figure 11, the outer ends 130 of which have a generally cylindrical configuration as shown. The inner yarn engaging face 132 of each block is flat, each block having on the upper edge thereof, which first meets the yarn in its travel thereby, a recess 134 in the shape of one-half a cone, the apex of which is positioned downwardly. When the two blocks 128 are pressed together the recesses 134 cooperate to lead the yarn therebetween in a path centrally thereof.

The two blocks 128 are pressed together with a predetermined force, thus allowing a predetermined tension to be placed upon the yarn, by the leaf springs 136, one spring being positioned in each of the oppositely disposed longitudinal slots 138 in the outer face of body 120. Each such spring has its lower end bent outwardly back upon itself, the spring being maintained in the slot by engagement of the hooked end 139 of such outer end of the spring partially around a cross-pin 140 in slot 138. The forward end of the spring 142 is bent inwardly and then outwardly as shown. The configuration of the spring is such that, when the forward ends 142 are not prized apart, the springs lie flat upon the bottom of the slot 138 and press blocks 128 together, when no yarn is passing between them, so that their faces 132 are in contact.

The tension device is provided with a means whereby the amount of force imposed upon the blocks by the springs, and thus the tension upon the yarn passing through the device, may be varied. In the preferred embodiment, such means takes the form of the sleeve 144 fitting about body 118, the sleeve having on its forward or lower end a shoulder 146 in the form of a cone converging toward the body 120. The sleeve may be adjusted longitudinally of body 118 by means of the nut 148 threaded upon the upper end of such body 118. By rotating the nut 148 in such direction as to thrust sleeve 144 downwards, in Figure 9, the ends 142 of the springs may be biased outwardly by the shoulder 146 in predetermined amounts, thus varying the force which the springs 136 exert inwardly upon blocks 128. The configurations of shoulder 146 and ends 142 of the leaf springs, and the total length of travel of sleeve 144 downwards, are so selected that the sleeve may be thrust to its stable end position, as shown

in Figure 10, to allow the blocks 128 freely to be thrust apart by yarn passing through and thus to relieve the yarn of any retarding tension.

The structure of the cabling unit 24 will be more readily apparent from a consideration of Figures 12, 13, and 14. As shown in Figure 12, supporting sleeve 56 is fixedly attached to support 58 and carries, rotatably mounted within it, the spindle 152, the lower ball bearing 154 and the upper ball bearing 156 providing such support of the spindle in the sleeve. In its upper portion spindle 152 is provided with an axial bore 158 for the reception of a cord guide, as will more clearly appear hereinafter.

Floatingly mounted on the upper end of the spindle is a structure for supporting a bobbin 162. Such structure includes a base member 160 supported on the spindle through the medium of the upper and lower ball bearings 164 and 166, respectivey, and a mandrel 168 forming an extension of the base member 160, the two parts 160 and 168 having upwardly converging conical surfaces, as shown, for supporting and driving connection with the inside of the bobbin 162.

The cabling unit of the invention includes means whereby the cabled yarn or cord is wound with a predetermined amount of tension. Although such tension determining means may take the form of a friction slip-clutch, in the preferred embodiment of the device there is employed a magnetic slip-clutch. Such device is made up of an outer cage member 170, shown attached to and depending from the bottom of the base member 160, and the inner rotor member 172 keyed to the spindle 152. The structure of such magnetic slip-clutch, which will be more fully explained in connection with Figures 13 and 14, is such that rotation of member 172 within member 170, the latter of which includes a strong permanent magnet, induces current in the first member and thus yieldingly connects the two members for rotation together. Thus the base member 160 and the bobbin mounted thereon is yieldingly driven from the spindle 152.

On the spindle 152 there is also mounted a disc 174 which is fixedly connected to the pulley 60. The disc 174 forms the base to which the cylindrical partial cover in the form of a can 176 is attached. Such can provides support for a U shaped tubular cord guide 178, the outer leg 180 of which is secured in upright position to the inside of the can, the bottom portion 182 of which is positioned radially on the top of disc 174, and the other or inner leg 184 of which is positioned within the bore 158 in the upper end of the spindle 152.

Also mounted on the spindle 152 is the disc 186, which is floatingly connected thereto through the medium of the ball bearings 187. Disc 186 serves as the support for a plurality of spaced upright standards 188, the tops of which are connected by the ring 190. Disc 186 is provided in one zone thereof with a heavy weight, such as the poured lead weight 189, so that the disc is unbalanced and that thus when the spindle is positioned at a substantial angle to the vertical, as indicated in Figure 1, the disc 186 and the structure attached thereto tend floatingly to remain in one angular position with weight 189 downwardly. Disc 186 also serves as support for the traverse mechanism 192 and the frame therefor, more clearly shown in Figures 15 to 19, inclusive, by which the guiding finger is supported and traversed up and down the length of the bobbin 162. In general such device includes a vertical rotatably mounted worm 194 driven from spindle 152 by means of the pulley 196 thereon, a flat belt 198 trained about such pulley and about a pulley 200 on the bottom end of the worm. As shown in Figure 19, there is provided a spring tensioned idler pulley 202 about which such belt runs, the idler pulley being mounted on the end of an arm 204 pivotally mounted on the disc 186, the arm being impelled outwardly by means of a coil spring 206.

The magnetic slip-clutch includes in its cage 170 the permanent magnet 208 the top surface of which is spaced from the bottom surface of part 160 as shown in Figures 12 and 14. Magnet 208 has a plurality of equally spaced pole pieces 210 formed on its inner, generally cylindrical surface. Such magnet is preferably made from the materials having high permeability, such as an alloy composed of 24—30% Ni, 9—13% Al, balance Fe, or an alloy composed of 24—30% Ni, 9—13% Al, 5—10% Co, balance Fe. The inner rotor 172 has its main body portion 211 made of soft annealed steel, there being provided on its periphery a sheath of non-magnetic metal 212 of high electrical conductivity, such as copper to provide a low resistance path for the eddy currents. It will be apparent that relative rotation between parts 170 and 172 induces electric currents in part 172, as in the rotor of a squirrel cage motor, and that the cage and rotor are thereupon coupled magnetically. The amount of torque at a given relative speed between the parts 170 and 172 depends upon the air-gap between them. Consequently variation of the air gap by suitable

dimensioning of the parts allows the selection of a predetermined amount of tension on the cord wound on the bobbin 162 driven by casing 170 of the clutch.

Because normal operation of the device involves considerable slip between the rotor and cage and thus appreciable eddy currents, there is substantial heating of the rotor. Heat is dissipated therefrom by providing a series of vertical holes 214 through the body 211 of the rotor 172, a series of holes 215 in disc 186, and an air impeller in the form of a fan 216 keyed to the spindle beneath member 174. When the spindle is rotated cooling air is thus caused to flow, as shown by the arrows in Figure 12, upwardly through the rotor 211, thence laterally into the spa e between the top of magnet 208 and the bottom of part 160, and finally outwardly through the angularly spaced radial openings 175 through the outer part of rotor 170 below the bottom surface of part 160.

The stepped capstan 33 at which the two twisted threads 28 and 32 are combined in untwisted side-by-side relationship also constitutes the means by which the number of turns per inch (pitch) in the cabling operation is governed. The capstan, which is shown with the three steps 218, 220, and 222 which are smoothly dished in axial cross-section, is driven at a speed bearing a definite relationship to the speed of rotation of the spindle 152, and thus at least approximately to the speed of rotation of the bobbin 162. The capstan, of course, receiving as it does threads 28 and 32 from units 20 and 22, respectively, also determines the rate of paying out of the single twisted threads from such units by at least substantially positively pulling the threads from the outer ends of the balloons in the threads created and maintained by their respective units 20 and 22. Variation in the number of turns per inch of the twist (pitch) in the single twisted threads may be accomplished by changing the diameter of drive pulleys 66 and 67 relative to that of pulley 60 driving the cabling unit. The surfaces of the steps 218, 220, and 222 of capstan 33 are each, in the embodiment shown, of partial toroidal shape. Such surfaces function, in the feeding of the combined but untwisted threads, in a manner more fully set out hereinafter.

The capstan 33 is affixed to the forward end of a cross shaft 224 journaled in pillow blocks on the top of the machine frame. Such shaft is driven through the medium of a chain 228 which runs over a sprocket 226 on the rear end thereof, and a sprocket 242 on a drive shaft 238, shown at the bottom in Figure 2. An adjustably positioned idler sprocket 230 is provided to maintain the chain 228 taut. Shaft 238 is driven from spindle 152 by means of a worm 232 affixed to the bottom of the spindle, such worm meshing with a worm gear 234 keyed on the forward end of shaft 236, the shaft being journaled in pillow blocks, as shown, on the machine frame. Because spindle 152 is positioned at an angle to the vertical, a universal joint 240, shown for simplicity in straight condition in Figure 3, but actually driving through a marked angle in the device shown in Figure 1, is employed. As above explained in connection with the manner of supporting the member 46, the front part 59 of the frame cross member, which is disposed at right angles to the spindle 152, is, in the actual machine, tipped at an angle to the horizontal equal to that which the spindle 152 makes with the vertical. Part 61 of the frame cross member, and shafts 224 and 238 are horizontal in the actual device.

Major changes in the speed ratio between spindle 152 and shaft 224, and thus changes in the number of turns per inch (the pitch) in the cabling operation, are effected by the use of suitable ratios of the sprockets 226 and 242. Minor changes in the pitch of the cabled cord, that is, number of turns per unit length, are made by shifting the threads 28 and 32 to the appropriate step of the capstan, such steps filling smoothly the gaps in the speed ratio obtainable by sprocket changes.

Each of the steps 218, 220, and 222 of the capstan 33, besides acting as a gathering point for the threads delivered from the twisting units 20 and 22, also functions as an automatic tension compensator and equalizer. The threads continually try to travel to the end of the step over which they are trained, because of the speed of the end and thus its frictional drag on the threads is greater than that of the center of the step. Slippage between threads and capstan step, however, limits travel of the threads toward the end of the step. The continual movement or "walking" of the threads axially of the capstan step tends to even out variations in tension in the threads. Thus the capstan 33, together with the compensator and shock absorber 35, applies a compensating tension to the threads passing thereover to control the balloons of the units 20 and 22, and functions to feed the threads to be cabled to the cabling unit under uniform tension. As a result the balloon of unit 24 is also controlled by the compensating tension applied to the combined as yet uncabled, threads passing over capstan 33 and through device 35.

The combined threads 28 and 32

untwisted on each other fed, from the capstan 33, travel to the compensator and shock-absorber 35 shown in Figure 2. Such device, which has an elongated horizontally disposed main frame 244, is supported from member 10 of the machine frame by the depending support 246. The compensator includes a thread guide pulley 248, the supporting block 251 of which is mounted for longitudinal travel on a longitudinal rod 250 supported by the main frame 244, parallel thereto but spaced therefrom, pulley 248 being thrust to the right in Figure 2 by means of a compression spring 252. Block 251 is bored to receive rod 250 therethrough, a key connection (not shown) being provided between the block and rod to prevent turning the block on the rod. The compensator is further provided with a fixed idler pulley 254 and a guiding eye 256 as shown in Figure 2, so that the combined threads fed downwardly from the capstan are first led over the pulley 248, thence to the left around the pulley 254, and from there through the eye 256 from which is emerges at 34 to travel downwardly and into the leg 180 of guide tube 178 of the cabling unit. The eye 256, as shown in Figures 2 and 3, is located substantially coaxial with the unit 24, and between the upper end of such unit and the capstan 33. Thus the balloon which forms in the cord 34 between eye 256 and the cord guide 180 is symmetrical about the axis of unit 24.

The construction of the transverse mechanism 192 and of the frame on which it travels will be clearly apparent by a consideration of Figures 15 to 19, inclusive. The frame on which such unit travels is mounted on the cabling unit 24, as shown in Figures 12 and 13, parallel to the axis of the spindle 152. Such frame consists of a bottom cross member 258, a similar top member 260, a first longitudinally extending frame member 262, and a second such member 264 parallel thereto. One of the standards 188 is, as shown, also utilized in forming such frame. Such frame is attached between the disc 186 and the top 190 so as to be fixed thereon.

The two longitudinal members 262 and 264 are provided with inwardly facing rack gears 266 and 268, respectively, the bottoms of such rack gears being connected by a short horizontal rack 270. The transverse mechanism 192 is made up of the front plate 272 and the rear plate 274, such plates being connected by suitable cross members, of which one is shown at 276 in the form of a bottom plate for such unit. The unit 192 is mounted and guided on the framework so as to travel from top to bottom thereof, such travel being effected as follows: the worm 194 is, as we have seen, driven by spindle 152 through the medium of belt 198, and pulleys 196 and 200. The transverse mechanism 192 has mounted therein a transverse shaft 280 on one end of which there is affixed a work gear 278 meshing with the worm 194. Also keyed to shaft 280 is a pinion 282. Journaled on the transverse mechanism frame coaxially of shaft 280 is a lever 284 which is provided with a cross-shaft 286 carrying a pinion 288 constantly in mesh with pinion 282. Pinion 288 has a diameter somewhat less than the distance between rack gears 266 and 268. Thus, rocking of the lever 284 in a clockwise direction (Figure 15) causes pinion 288 to mesh with rack gear 268 and rocking of such lever in a counter-clockwise direction frees pinion 288 from contact with rack 268 and causes it to mesh with rack 266. The lever is provided with an arm at 290 and with a cam follower 292 on the end thereof, such cam follower cooperating with an upstanding cam track 294 affixed to the frame member 262. The cam track is provided at its bottom with an opening 296 through which the cam follower 292 may pass. The cam track terminates at its upper end at 298. In order to position lever 284 stably, a coil spring 291 is positioned between the arm and the frame of the transverse mechanism to urge the lever in a clockwise direction, as shown in Figure 15.

From the above description the manner of operation of the transverse mechanism will be apparent. Rotation of worm 194 in one direction drives worm wheel 278 and thus pinions 282 and 288, causing such latter pinion to climb up or down the rack with which it is in mesh carrying with it the unit 192. Assume for example, that the worm is driven in such direction that the transverse mechanism is progressing downwardly (Figure 15). When pinion 288 reaches the bottom of rack 268 it then meshes with transverse rack 270, which causes lever 284 to be rocked counterclockwise, against the action of spring 291, since at this point the cam follower 292 lies opposite opening 296 in the cam track. The follower then travels upwardly to the right of the track, thus preventing the spring 291 from returning the lever to its former position. Pinion 288 then meshes with rack 266, and, still rotating in the same direction, causes the transverse mechanism to climb in the frame. The unit continues travel in such direction until the cam follower 292 clears the upper end 298 of the cam track. Spring 291 then turns the lever clockwise to cause it to assume the position shown in Figure 15, so that the unit then again

travels downwardly.

The transverse mechanism above described forms the support by which the guiding finger is traversed up and down the length of the bobbin 162. Support for such finger on the transverse mechanism is afforded by a mounting plate 300, to which the guiding finger and the support therefore more clearly shown in Figures 20, 21, and 22, are attached. Such guiding finger support consists of the main body 302 which is pivotally mounted on an axis parallel to the axis of the bobbin on an attaching means 304. Means 304 in turn, is attached to plate 300. Means 304 has two spaced ears 308 between which are received the spaced ears 312 on the rear end of body 302. A shaft 306 is received in openings through the two pairs of aforementioned ears, being pinned as shown to ears 308. A toothed or ratchet wheel 310 is positioned on shaft 306 between ears 312 and is pinned to such shaft. There is provided a pawl in the form of a leaf spring 314, the forward end of which is secured to the body and the rear end of which normally impinges on the ratchet wheel. It will be seen, particularly by considering Figure 21, that when the pawl 314 is in operative relationship, body 302 may be swung quite freely in a clockwise direction but it is prevented from moving counter-clockwise by the pawl. Thus the guiding finger mounted on body 302 is prevented from becoming jammed against the bobbin 162 or the cord 37 wound thereon. The finger is initially positioned by being placed in contact with the bobbin of the cord wound thereon, at its greatest diameter, after which the finger is automatically thrust outwardly at each repeated contact between it and the portion of the wound cord of greatest diameter. The pawl may be released to swing the body 302 counter-clockwise, when required, by means of a plunger 316 which when pressed upwardly (Figure 21) removes the rear end of the pawl from contact with the ratchet wheel 310.

The guiding finger, shown generally at 318, is adjustably mounted on the forward end of the body 302 so that it may be varied in its effective length. The forward end of the finger is provided with a guide shoe 320 which lies close to or engages, as the case may be, the outer layer of cord on the bobbin, thus insuring correct placement of the cord being laid. Body 302 is provided with an idler pulley 322 under which cord 36 travels prior to its entry in the guide opening in the shoe 320.

The cabling unit 24 is also provided with an upwardly and inwardly inclined guide arm 324 positioned on top of the ring 190, such arm carrying an upper idler guide pulley 326 and a lower idler guide pulley 328. The two threads 28 and 32, combined, as explained, in untwisted parallel relationship at the capstan 33 travel in that condition through the compensator 35. Immediately on emerging from the eye 256 the two threads are cabled. The first twist of such cabling is given them in that portion of their travel in which the cord forms a loop or balloon which travels in free flight through the air, that is from the rotation of the disc 174 and thus the cord guide carried thereby. Such first twisted cord is then given a second twist, in the same direction, in that portion of its travel, shown at 36, from the inner end of leg 182 of the cord guide to upper guide pulley 326. The cabling or take-up twisting unit 24 thus functions to "two-for-one" twist the elongated flexible material such as the cord passing thereinto, and may properly be called a "two-for-one" twisting and coiling spindle. The double twisted cord then travels downwardly around the guide wheel 328, under guide wheel 322 on the traverse mechanism, and thence to the shoe 320 of the guiding finger 318 where it is laid on the bobbin 162 to form the wound package 37.

The overall operation of the illustrative embodiment may be summarized as follows:

The yarn extending from each of the singles or supply twisters 20 and 22 undergoes one twist per spindle revolution while in the twister and is given a second twist by being rotated around the twister or source of supply in the form of a balloon which exerts centrifugally a pull at its supply end counteracted by the back tension of the tensioning device on the twister spindle. A similar pull or tension exists on the twisted material at the other or outer end of the balloon. From there the material extends over the gathering pulley and the compensator in gathered relation to similar material extending from the other supply balloon, and thence it enters directly into the outer end of the central cabling or take-up balloon which rotates freely around the take-up twister 24. The cabling or take-up balloon exerts centrifugally a pull on the material opposing the pull exerted thereon by the supply balloon or balloons, and differences between these opposing pulls or tensions are compensated by the frictional slip driving action of the gathering pulley or the frictional resistance which it imposes against travel of the gathered material at a speed exceeding the speed of the pulley surface, and/or the variable drag of the spring tensioned compensator. Thus the several

balloon formations are continuously maintained even though the materials undergo continuous longitudinal travel from the yarn supply bobbins to the cord storage bobbin.

The material at the inner or lower end of the cabling or take-up balloon extends into the flyer and spindle of the take-up twister and thence is drawn in and reeled on the bobbin of this twister, having been twisted once per take-up twister revolution while in the balloon and twisted a second time while passing to and through the spindle. Since the supply and take-up balloons rotate in a counterbalanced relation and automatically maintain balancing tensions at their respective outer and inner ends, the continuous positive drawing or winding in of the cabled material simply causes continuous longitudinal travel of the materials through the balloons from the supply bobbins to the cord bobbin, and in the course of this travel two complete two-for-one twistings are imparted to produce a multiple twisted material or cord of high quality in a simple and economical manner. By plurally twisting the material or cord is meant a twisting operation by which the material or cord is given more than one twist per revolution about the axis of twisting.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. The method of producing twisted filamentary material, characterized in that it comprises continuously twisting a strand of filamentary material such as yarn extending from a source of supply thereof in a loop while rotating such loop about the supply source to form a first balloon, forwarding twisted material from said balloon into another loop and thence into a take-up portion of the path of the material, continuously twisting the forwarded material by rotating the loop thereof about said take-up portion to form a second balloon which exerts centrifugally a pull on the twisted material opposing the centrifugally exerted pull thereon of said first balloon, and continuously taking up the material within the orbit of said second balloon to maintain continuous longitudinal travel of material from the supply source through the balloons while plurally twisting the material.

2. The method according to claim 1 characterised in that tension is applied to the material extending between said balloons to compensate for a difference in the respective pulls thereon of the said balloons.

3. The method according to claim 1 or 2, characterised in that the loop forming said second balloon is rotated in an orbit isolated from the orbit of said first balloon.

4. The method according to claim 1, 2 or 3, characterised in that it includes imposing a predetermined back tension on a portion of the strand of filamentary material extending between the supply source and the first balloon, so as to counteract the pull exerted on such portion by such balloon.

5. The method according to any of claims 1 to 4, characterized in that two or more such strands extending from separate supply sources are twisted in respective first balloon forming loops as aforesaid, and the twisted materials forwarded from the first balloons are gathered together and forwarded together into such other loop so as to be cabled by the continuous twisting of the forwarded material as aforesaid.

6. The method according to any of claims 1 to 5, characterised in that it includes two-for-one twisting said strand or each of such strands of filamentary material by imparting a first twist to a portion of the same extending between its supply source and the corresponding first balloon and imparting a second twist to a reversely extending portion thereof forming such balloon; and two-for-one twisting the forwarded twisted material or materials by imparting a first twist thereto in said second balloon and imparting a second twist thereto in a portion thereof extending in a reversed path between said second balloon and the point of taking up the material.

7. The method according to any of claims 1 to 6, characterised in that it comprises continuously taking up the material within the orbit of the second balloon by positively pulling the material from said balloon, and consequently from the first balloon or balloons and the supply source or sources, at any rate synchronized with the respective rates of rotation of said balloons.

8. The method according to any of claims 1 to 7, characterized in that it includes coiling within the orbit of the second balloon the material taken up therewithin.

9. An apparatus for producing twisted filamentary material according to the method of any of claims 1 to 8, characterised by including a two-for-one twisting spindle of the type which holds a supply of the filamentary material and forms a strand of the same issuing therefrom into the first balloon, means associated with said spindle for imposing a predetermined

back tension on such strand, a two-for-one twisting device of the type which receives and takes up filamentary material and forms the material received into a balloon rotating about a take-up portion of the material, such device including means for positively drawing in twisted material from the first balloon continuously into the latter balloon to form the latter; and means for driving said twisting spindle and said twisting device in synchronism.

10. Apparatus according to claim 9, characterised in that it also includes tension compensating means acting on the material extending between said balloons.

11. Apparatus according to claim 10, characterised in that the means for leading the twisted material from the first balloon into the latter balloon also constitutes a tension compensating means.

12. Apparatus according to claim 9, 10 or 11, characterised in that it includes two or more twisting spindles of the type described, each forming a first balloon in an orbit isolated from the orbit of the other, together with means for gathering together the twisted materials from the respective first balloons so that that are led together into the latter balloon, the twisting device forming the latter balloon in an orbit isolated from the respective orbits of the first balloons.

13. Apparatus according to claim 12, characterised in that said gathering means also constitutes a means for leading the twisted materials from the first balloons continuously into the latter balloon.

14. Apparatus according to any of claims 9 to 13, characterised in that it includes means for driving the drawing in means of said twisting device in synchronism with said twisting spindle or spindles and said twisting device.

15. Apparatus according to any of claims 9 to 14, characterised in that said twisting device includes a bobbin support within the orbit of the latter balloon, slip driving means for rotating said support with a bobbin thereon to coil twisted material on the bobbin, and a traverse mechanism for delivering the twisted material to said bobbin.

16. Apparatus according to any of claims 9 to 15, characterised in that the twisting spindle or each of the twisting spindles is of the type which imparts a first twist to the strand of material in an axial passageway of the spindle and which delivers the strand from such passageway into a reversely extending balloon forming loop wherein a second twist is imparted to the material on each rotation of the spindle.

17. Apparatus according to claim 16, characterised in that the balloon forming loop extends to and through a relatively stationary guide located substantially in line with the axis of the spindle.

18. Apparatus according to any of claims 9 to 17, characterised in that said twisting device is of the type which imparts first twist to the material or the gathered materials in the balloon formed by such device, and which imparts a second twist to the same in an axial passageway of such device through which the twisted material or materials passes from such balloon.

19. Apparatus according to claim 18, characterised in that it includes a relatively stationary guide which is located substantially in line with the axis of the twisting device and over which the twisted material or materials pass into the balloon formed by such device.

20. Apparatus according to any of claims 9 to 19, characterised in that the respective axes of the twisting spindle or spindles and the twisting device are disposed in general parallel relation.

21. Apparatus according to claim 12 or claim 12 and any of claims 13 to 20, characterised in that the means for gathering twisted materials from the first balloon is located substantially equidistant from the twisting spindles.

22. Apparatus according to claim 12 or claim 12 and any of claims 13 to 21, characterised in that the means for gathering twisted materials from the first balloon comprises a rotary capstan about which such materials are wrapped in gathered relation.

23. Apparatus according to claim 22, characterised in that it includes means for restraining the rotation of said capstan.

24. Apparatus according to claim 22, characterised in that it includes means for maintaining the capstan in rotation at a speed sychronised with the speeds of rotation of said twisting spindles and said twisting device.

25. Apparatus according to claim 15 or claim 15 and any of claims 16 to 24, characterised in that said twisting device includes a rotary spindle, said bobbin support being mounted on and rotatable relative to said spindle, and said slip driving means comprises a permanent magnet member and a cooperating magnetic member in spaced relation thereto, one of said members being fixed to said spindle and the other being fixed to said bobbin support.

26. Apparatus according to any of claims 9 to 25, characterised in that said twisting device includes a twisting disk carried and rotated by the spindle of such device and having a radial guide passage

receiving material from the balloon of such device.

27. Apparatus according to claims 15 and 26, characterised in that said twisting disk carries a cylindrical container extending upwardly therefrom to at least partially enclose the bobbin.

28. Apparatus according to any of claims 9 to 27, characterised in that said twisting device includes a spindle having a cage floatingly mounted thereon, said cage being normally held in a stationary position relative to said spindle by a weight mounted eccentrically on said cage.

29. Apparatus according to claims 15 and 28, characterised in that said traverse mechanism is supported by said cage.

30. Apparatus according to any of claims 9 to 29, characterised in that said means for applying back tension on material from the twisting spindle, or from each of two twisting spindles, is adjustable to change the tension applied thereby.

31. A method of producing twisted filamentary material substantially as hereinbefore described with reference to the accompanying drawings.

32. Apparatus for producing twisted filamentary material substantially as hereinbefore described with reference to the accompanying drawings.

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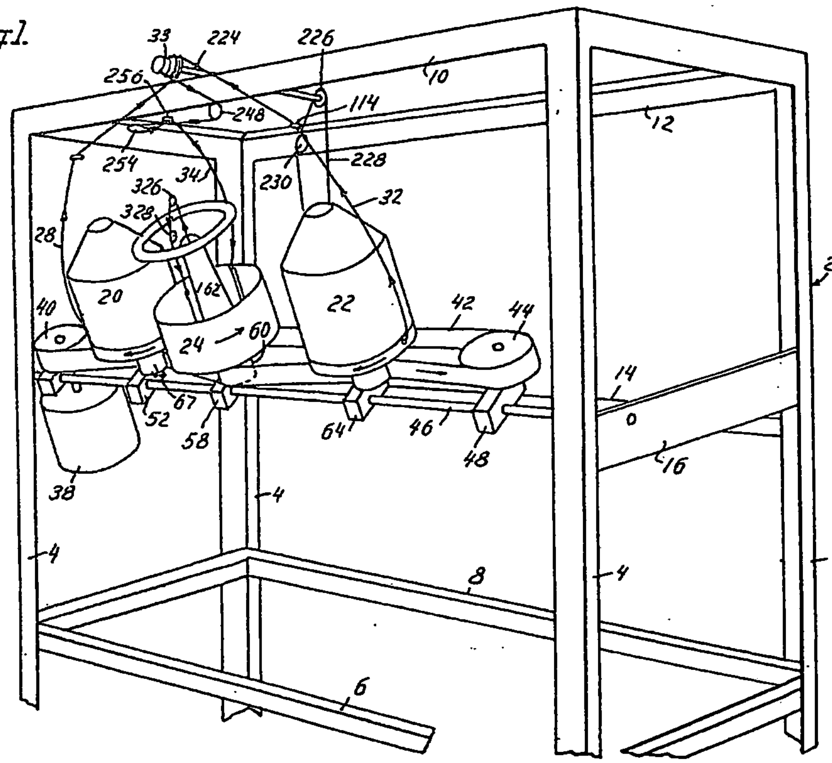
Fig.1



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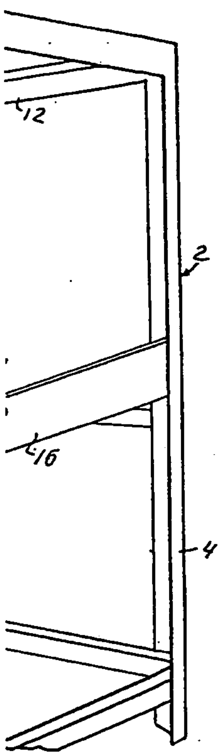
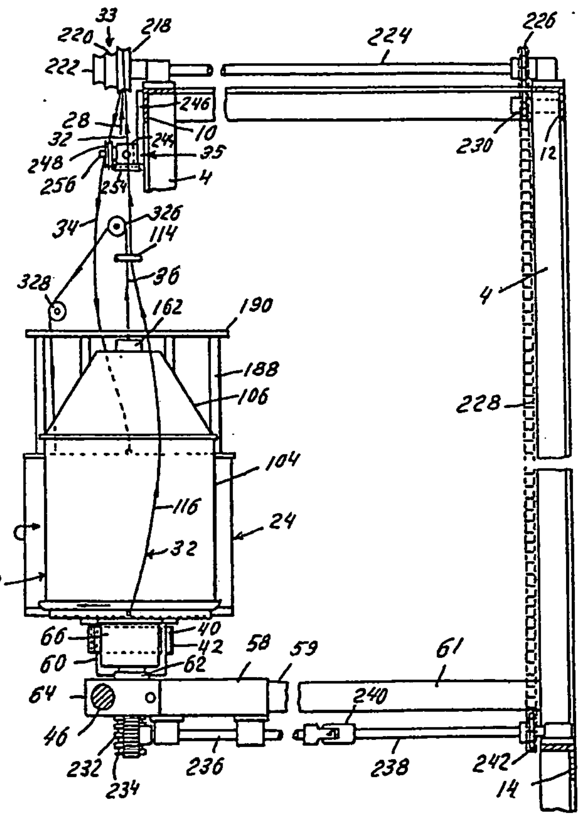


Fig.3.



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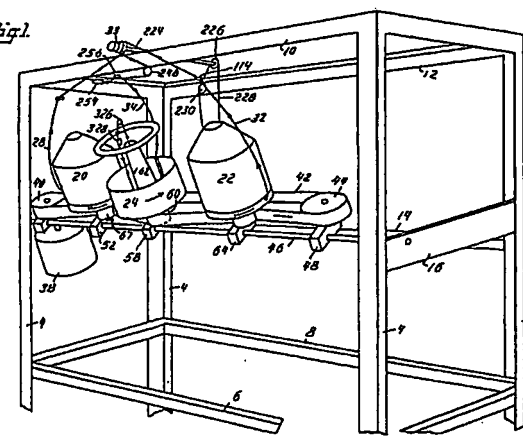

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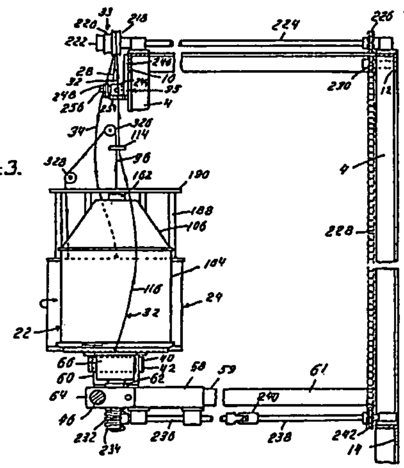

Fig.2.

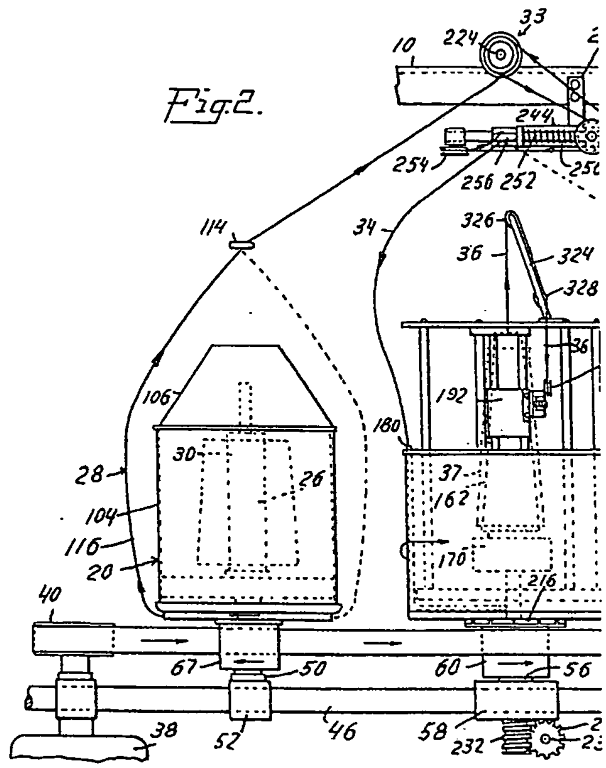
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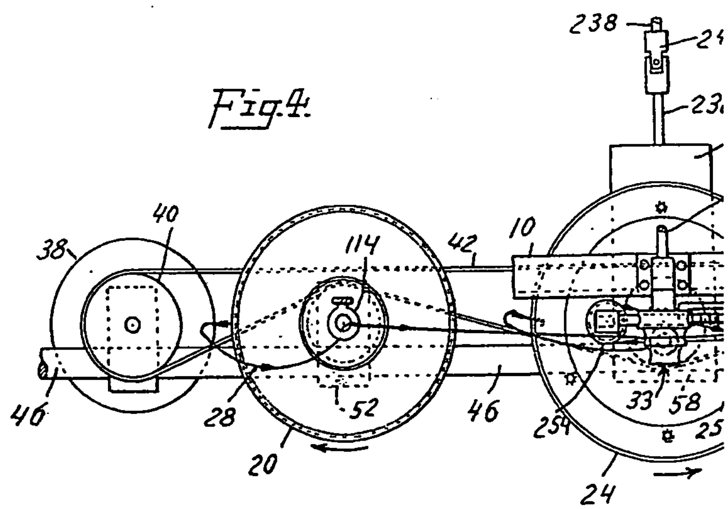
Fig.4.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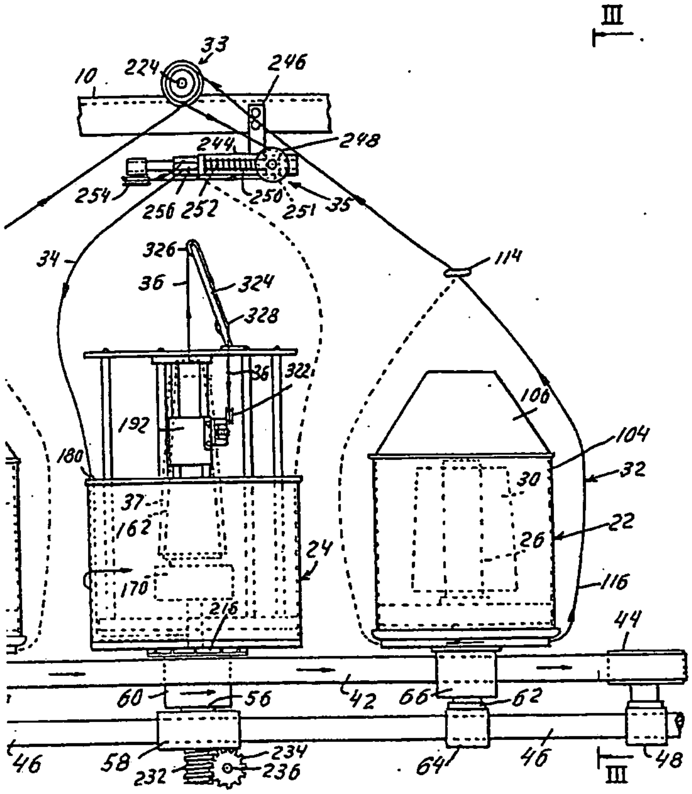

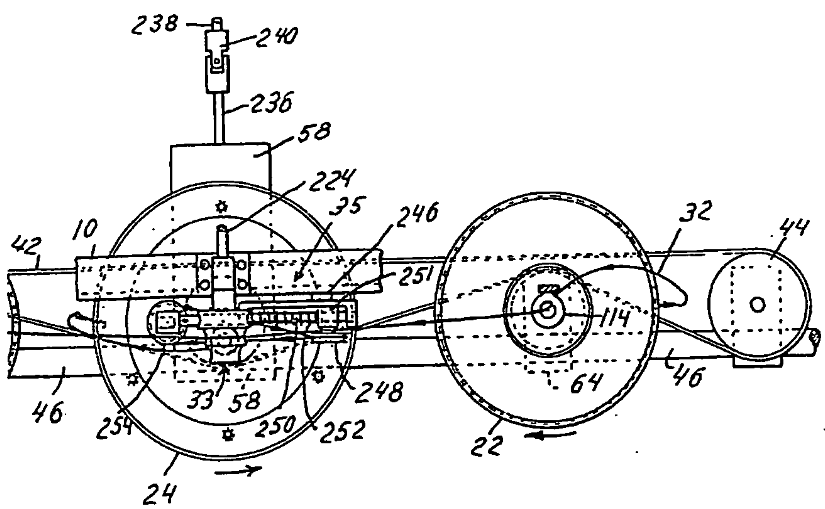

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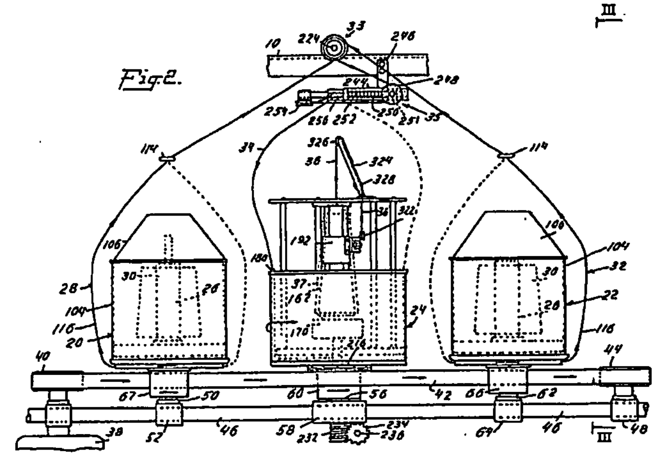

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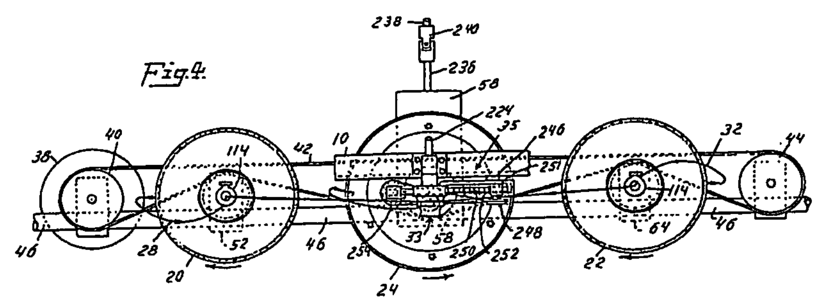

Fig.5.

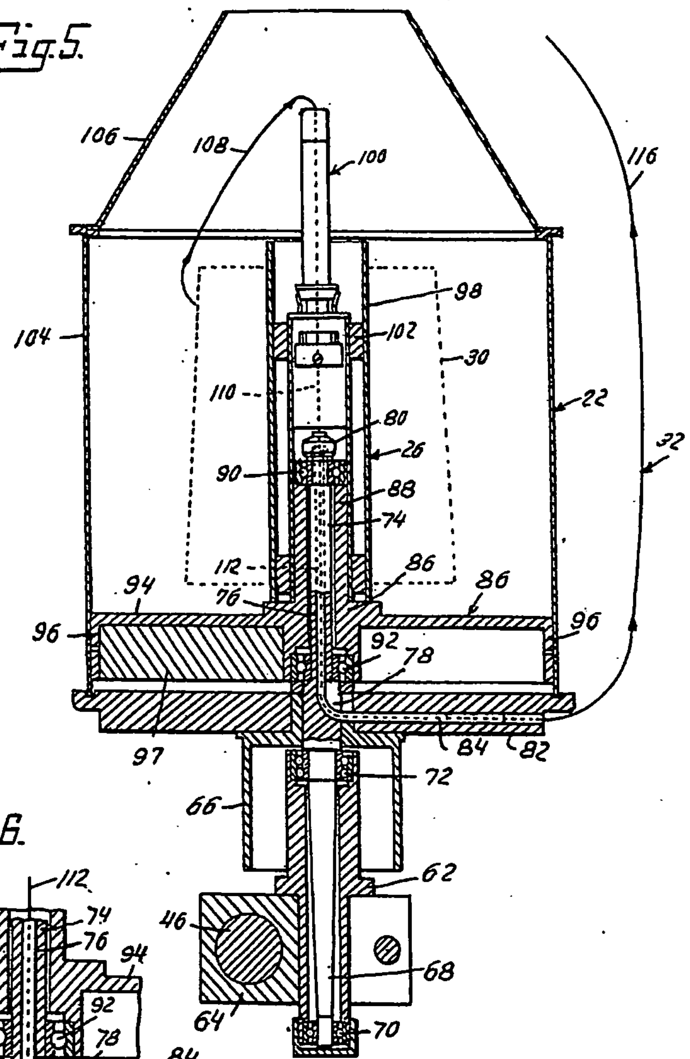

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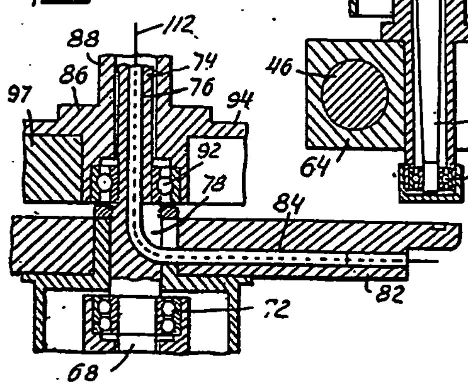
Fig.6.



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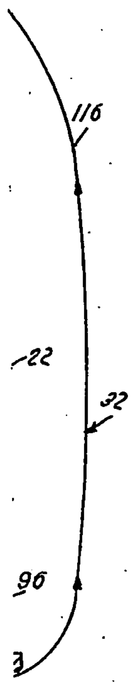
SHEETS 5 & 6



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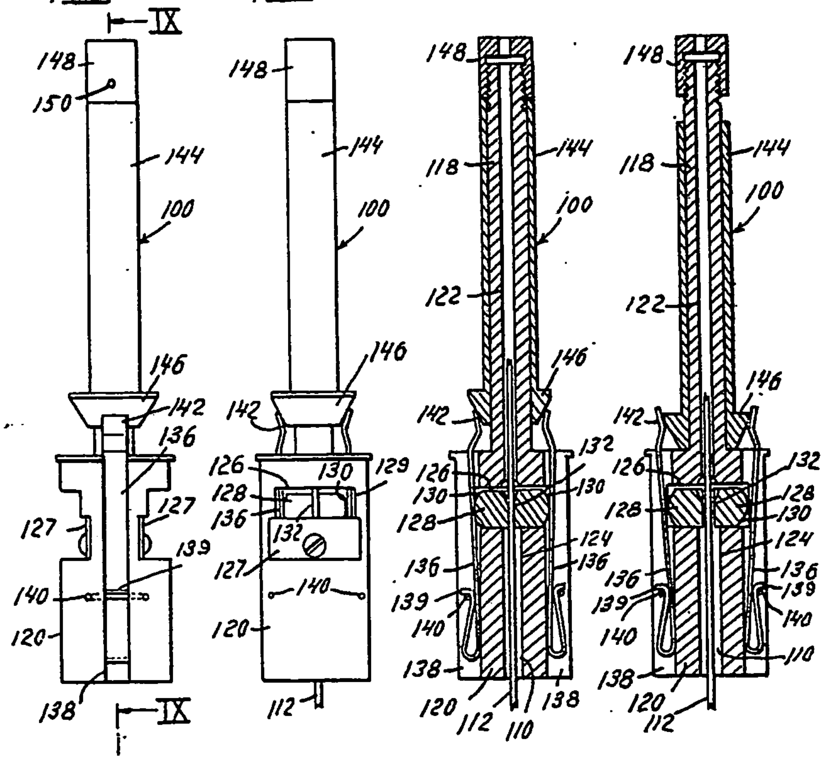

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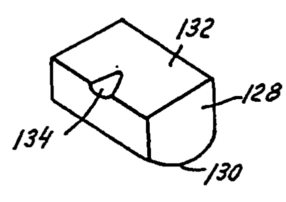

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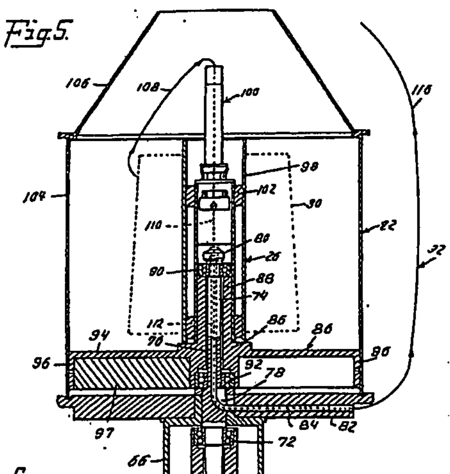
Fig.5.



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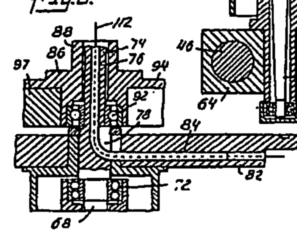

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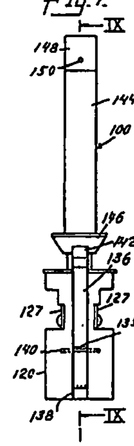

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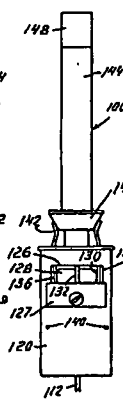

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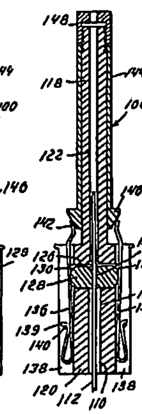

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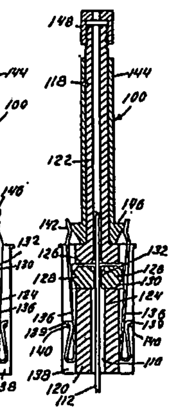

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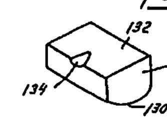

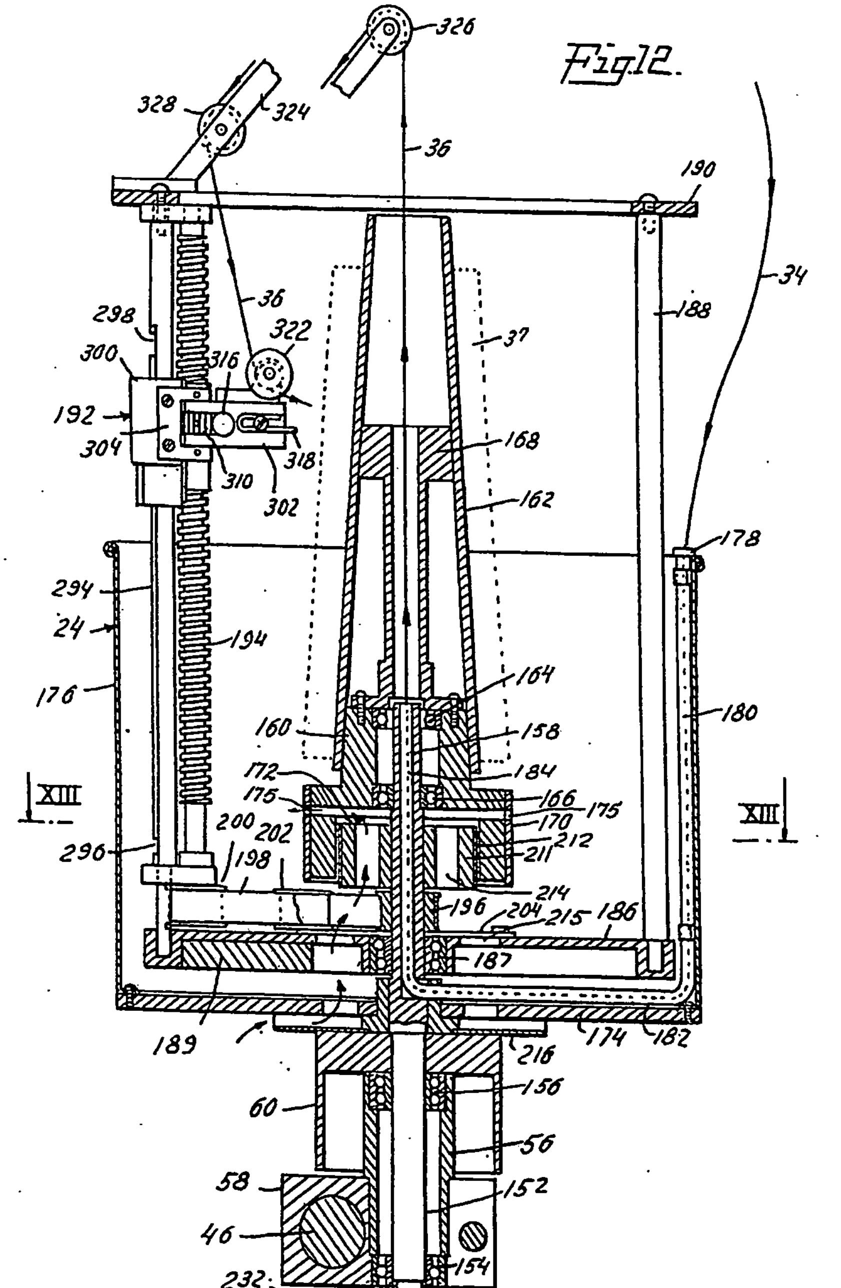

Fig12.
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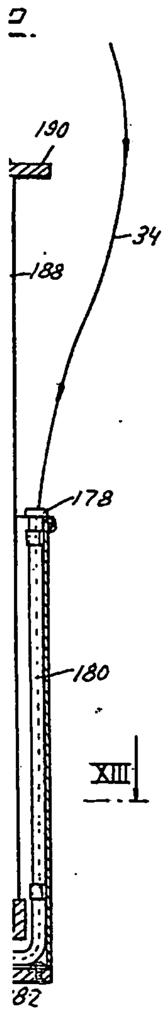
SHEETS 7 & 8



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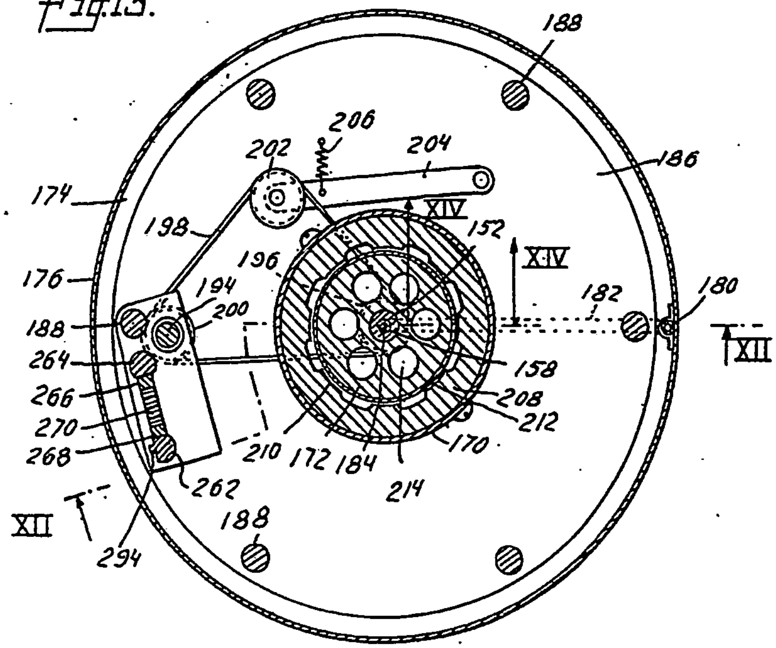

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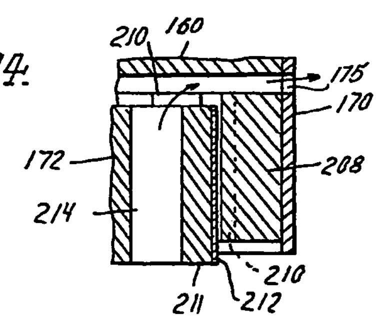

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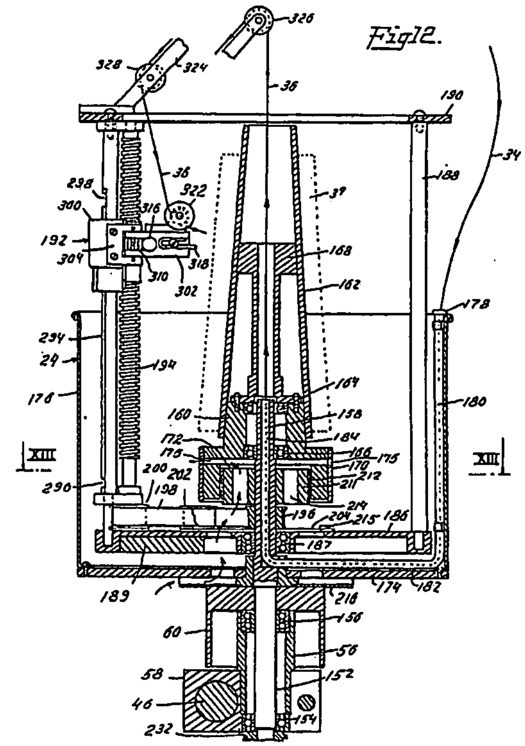

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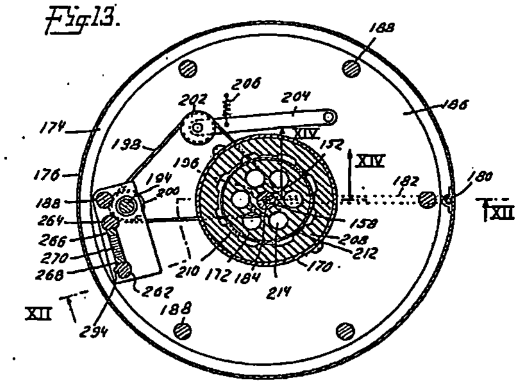


Fig.14.

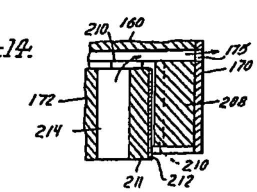
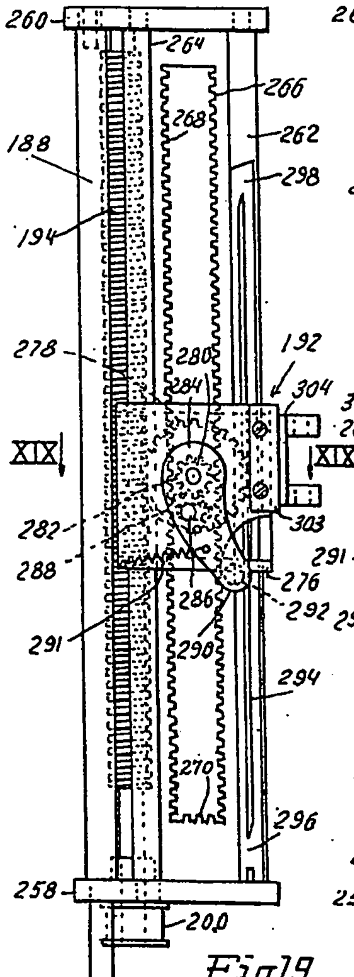


Fig.15.



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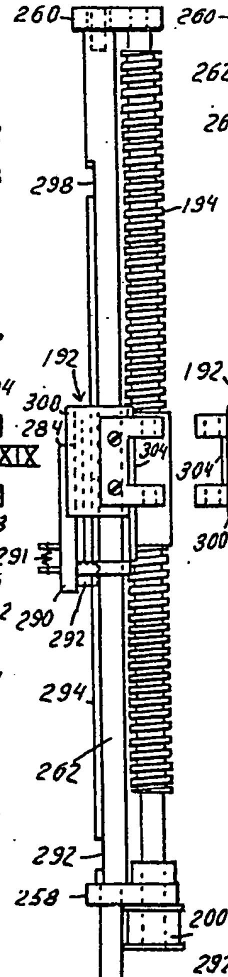

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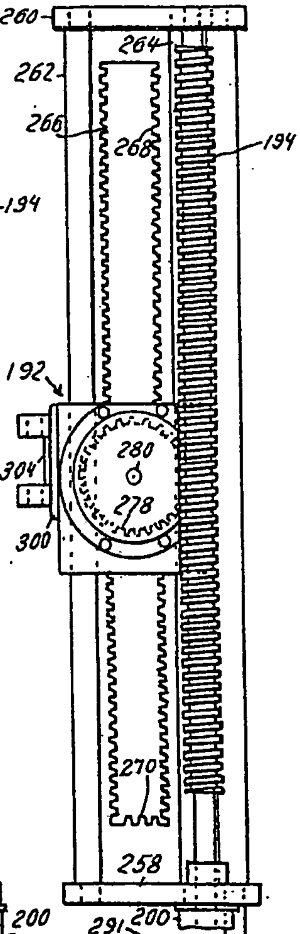

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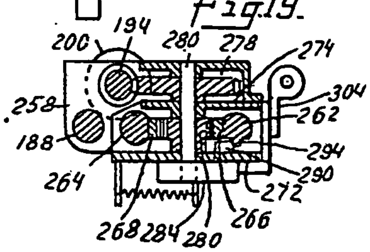

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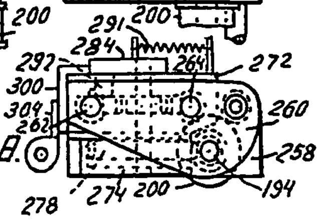
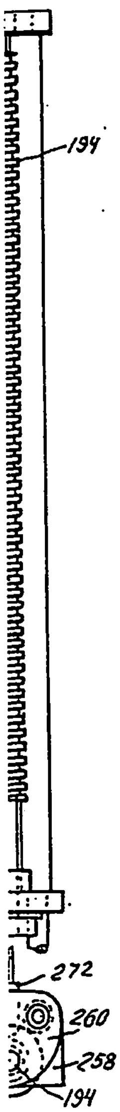


692,027 COMPLETE SPECIFICATION

10 SHEETS This drawing is a reproduction of the Original on a reduced scale.

SHEETS 9 & 10



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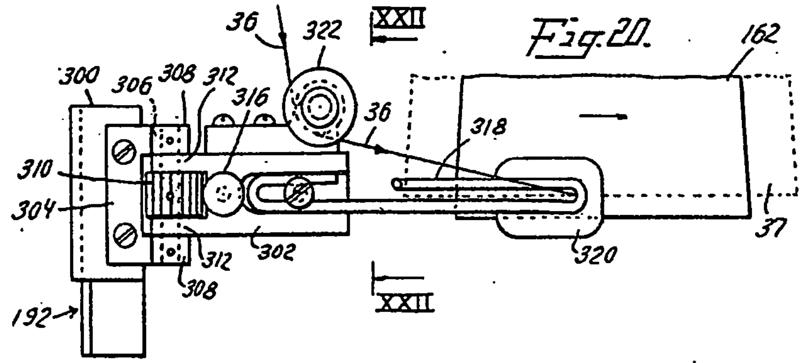


Fig. 21.

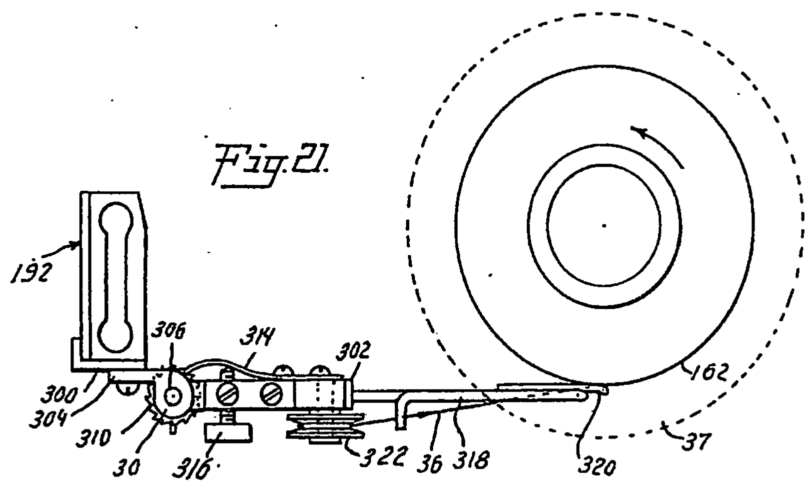
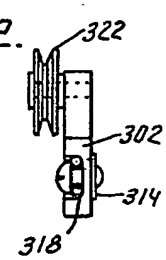
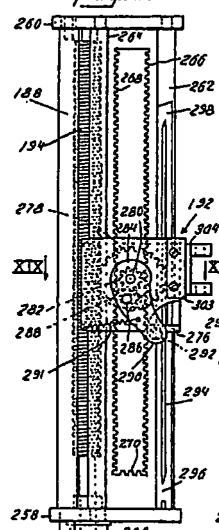


Fig. 22.



692,027 COMPLETE SPECIFICATION
10 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEETS 9 & 10

Fig. 15.



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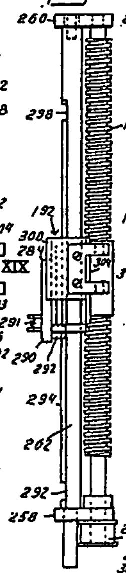

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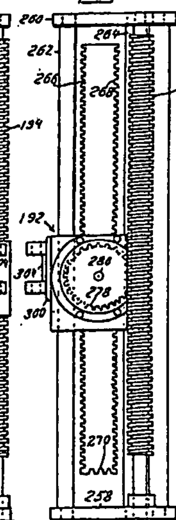


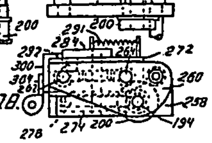


Fig. 18.

Fig. 19.

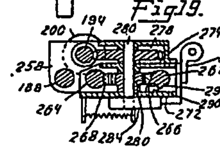
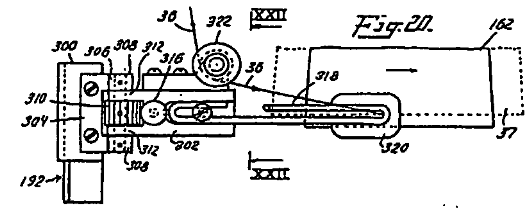


Fig. 20.



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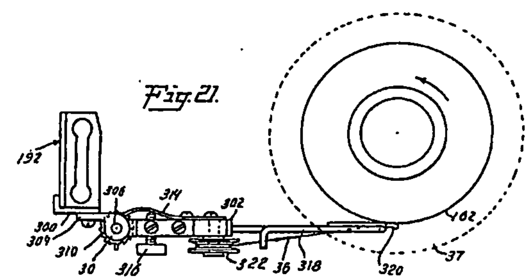

Fig. 22.